Citation:

Berkey CS, Rockett HR, Willett WC, Colditz GA. Milk, dairy fat, dietary calcium, and weight gain: a longitudinal study of adolescents. *Arch Pediatr Adolesc Med*. 2005 Jun;159(6):543-50.

PubMed ID: 15939853

Study Design:

Longitudinal Observational Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To assess the associations between milk, calcium from foods and beverages, dairy fat and weight change over time using data from the Growing Up Today Study, which is an on-going cohort study of more than 10,000 US children.

Inclusion Criteria:

- Children 9-14 years old in 1996
- Involved with the Growing up Today Study, which consists of 16,771 children residing in 50 states who are offspring of Nurses' Healthy Study II participants.

Exclusion Criteria:

- Any height that was more than 3 standard deviations away from the sex- and age-specific mean height (0.50% of heights excluded) and any 1-year height change that declined more than 1 inch or increased by more than the 99.7th percentile of the sex- and age-specific height growth distribution (1.36% excluded)
- Any BMI less than 12.0 as a biological lower limit (clinical opinion) and any BMI more than 3 standard deviations above or below the sex- and age- specific mean (log scale, 0.97% excluded)
- Total energy intakes <500 kcal/day or >5000 kcal/day were excluded as implausible total energy intakes (0.53% excluded)
- Estimates of total physical activity that exceeded 40 hours/week were deemed implausible and excluded (3.60%)
- Weekly hours of recreational activity exceeding 80 hours/week were deemed implausible and excluded (0.89%)

Description of Study Protocol:

Recruitment: Children between the ages of 9-14 years involved in the Growing Up Today Survey

Design: Longitudinal observational study

Blinding used: N/A

Intervention: None

Statistical Analysis:

- Mixed linear regression models - used to take within child correlations into account of BMI change
- Multivariate models - used for milk, calcium, dairy fat and energy intake together

Data Collection Summary:

Timing of Measurements: Participants were mailed follow-up questionnaires to update their information in 1997, 1998 and 1999.

Dependent Variables

- Weight gain

Independent Variables

- Milk
- Dietary calcium
- Dietary fats

Control Variables

- Race
- Ethnicity

Description of Actual Data Sample:

Initial N: 16,771 children

Attrition (final N): 12,829 children

Age: 9-14 years old

Ethnicity: Mostly white (94.68%)

Other relevant demographics: Not noted

Anthropometrics: 14.55% of the boys and 12.67% of the girls were overweight, 8.71% of the boys and 4.79% of the girls were obese and 4.16% of the boys and 4.68% of the girls were very lean

Location: Subjects resided in the 50 states

Summary of Results:

Key Findings

- Boys consumed (baseline means) 2.2 servings of milk per day and girls consumed 1.9 servings of milk per day
- Milk intake declined as the children grew older. Among children who completed the FFQ all 4 years, boys consumed (on average) 2.3 servings per day in 1996 but only 2.0 by 1999 and girls consumed 2.0 servings per day in 1996 which declined to 1.7 by 1999
- Skim and 1% milk appeared to be more strongly linked (per serving) to weight gain then whole or 2% milk
- Supplemental calcium was not associated with weight change (girls: P=0.72; boys: P=0.19)
- Fat from dairy was not a stronger predictor of weight gain than other types of fat and no fat (dairy, vegetable or other) intake was not significantly associated with weight gain after energy adjustment nor was total fat intake
- Girls (n=129) who reported consuming more than 3 servings per day of white milk every year gained 0.213 (P=0.24) more BMI than girls (n=652) who consistent consumed 2 to 3 servings per day (statistically insignificant)
- Boys (n=129) who consumed more than 3 servings per day every year similarly gained more BMI (0.262; P=0.19) than boys (n=499) who consistently consumed 2 to 3 servings per day (statistically insignificant)
- Boys who drank more than 3 servings per day of milk were 35% more likely to become overweight (relative risk (RR)= 1.35; 95% confidence interval (CI), 0.96-1.90) during 1 year than boys who drank more than 1.0 but less than or equal to 2.0 servings and were 26% more likely to become overweight than boys who drank more than 2.0 but less than or equal to 3.0 servings (RR=1.26; 95% CI, 0.95-1.66) (statistically insignificant)
- Girls who drank more than 3 servings per day were 36% more likely to become overweight (RR=1.36; 95% CI,

0.92-2.01) than those who drank more than 1.0 but less than or equal to 2.0 servings and were 25% more likely (RR=1.25; 95% CI, 0.91-1.72) than those who drank more than 2.0 but less than or equal to 3.0 servings (statistically insignificant).

Association Between Milk Consumption and 1-Year Change in BMI, Estimated Using Annual Data From 1996 Through 1999

	0 to ≤0.5 (Referent)*	0.5 to ≤1.0*	1.0 to ≤2.0*	2.0 to ≤3.0*	≥3.0*	β	*P* value
Boys (n=5550)							
Percentage of boys in each category	9	23	16	30	23		
BMI change β±SE	0.0	0.052±0.049	0.005±0.051	0.022±0.047	0.081±0.048	0.019±0.009	0.03
Girls (n=7279)							
Percentage of girls in each category	16	27	13	29	15		
BMI change β±SE	0.0	0.058±0.031	0.072±0.036	0.056±0.029	0.093±0.034	0.015±0.007	0.04

*Milk category, servings per day\

Author Conclusion:

- Children who reported higher total milk intake experienced larger weight gains
- Children who drank more 1% and skim milk had larger weight gains than those who drank smaller amounts of 1% and skim milk
- Dietary calcium intake was positively correlated with weight gain and dietary fat was not.

Reviewer Comments:

- *It was not noted if any of the milk consumed by the subjects was from rBGH-treated cows (rBGH elevates levels of insulinlike growth factor I in commercial milk and may contribute to weight gain)*
- *Since this study was a longitudinal observational study, it cannot infer causality as defined by randomized trials and some residual and unmeasured confounding may remain*
- *The necessity to collect data on youths by self-reporting using mailed questionnaires*
- *The cohort was not representative of US children.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	Yes
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A

5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	Yes
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	Yes
6.6.	Were extra or unplanned treatments described?	Yes
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes

	8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
	8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
	8.6.	Was clinical significance as well as statistical significance reported?	Yes
	8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**		Yes
	9.1.	Is there a discussion of findings?	Yes
	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		Yes
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	Yes